



ERBS/ERBE NON-SCANNER MEASUREMENT PRECISION 1984-1999

Robert B. Lee III^{*a}, Kathryn A. Bush^{b}, Jack Paden^{**b}, Dhirendra K. Pandey^{**b}, Robert S. Wilson^{**b}, and G. Louis Smith^{***c}**

^aNASA Langley Research Center,

^bScience Applications International Corp,

^cNational Institute for Aerospace



OBJECTIVES

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- EXTEND IN-FLIGHT CALIBRATIONS TO COVER OCTOBER 1999 THRU DECEMBER 2003, ERBE EARTH IRRADIANCE MEASUREMENTS.
- ACCOUNT FOR VARIATIONS IN ERBE EARTH IRRADIANCE MEASUREMENTS DUE TO VARIATIONS IN THE ERBS SPACECRAFT ALTITUDE.



OCTOBER 5, 1999, THE ERBE
ELEVATION DRIVE FAILED
PREVENTING ON-ORBIT
CALIBRATIONS OF THE ERBE ACR'S
USING THE BUILT-IN BLACKBODIES,
TUNGSTEN LAMP, AND SUN [THRU
SPECIAL SOLAR VIEWING PORTS].



SUMMARY

1984-1999, TOP-OF-THE-ATMOSPHERE (TOA) ERBE NONSCANNING ACR MEASUREMENTS CONTAINED AN 1.7 Wm^{-2} INCREASE, WHICH WAS CAUSED BY THE ERBS SPACECRAFT ALTITUDE DECREASING FROM 611 km TO 587 KM.

1984-1999, ERBS/ERBE NONSCANNING ACTIVE-CAVITY RADIOMETERS (ACR) MEASURED EARTH IRRADIANCES AT THE 0.3 Wm^{-2} ACCURACY LEVEL AT SATELLITE ALTITUDE (SA).

ANALYSES 2002-2003 SA, 180-DEGREE ERBS SPACECRAFT PITCH MANEUVER SOLAR CALIBRATIONS INDICATE THAT THE 1999 GAINS, ALONG WITH THE CORRESPONDING 2000-2003 ACR OFFSETS CAN BE USED TO REDUCE THE OCT. 1999 THRU DEC. 2002 SA EARTH FLUX MEASUREMENTS AT THE 0.5 Wm^{-2} PRECISION LEVEL.

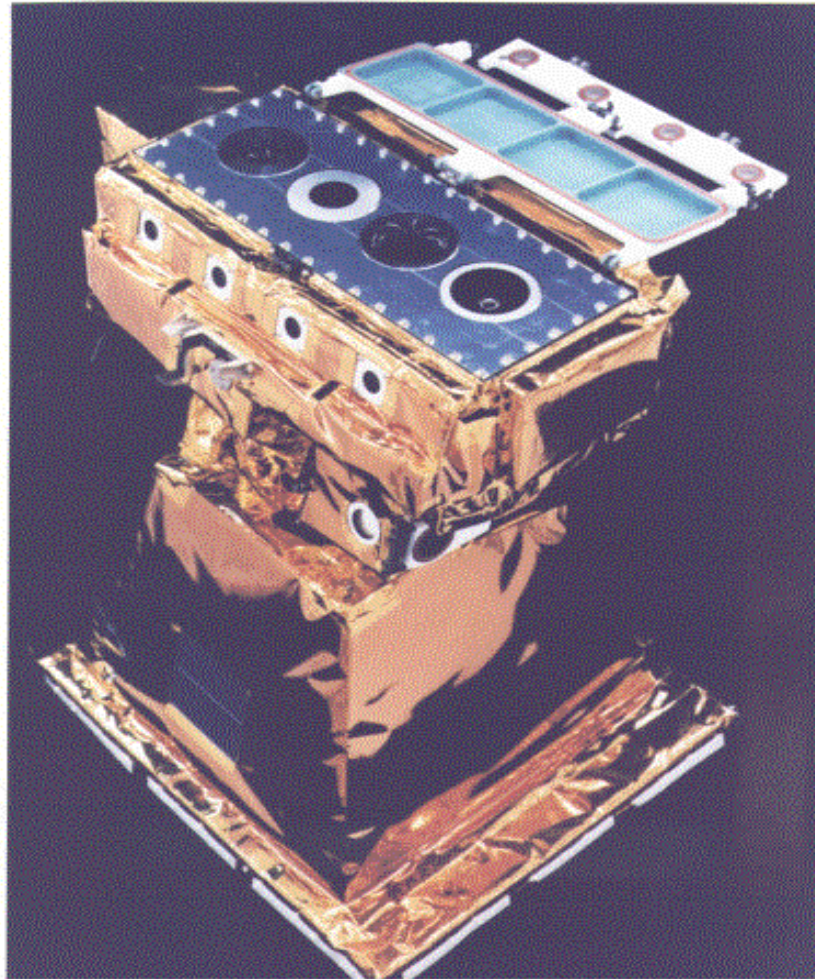


EARTH RADIATION BUDGET SATELLITE (ERBS), LAUNCHED OCTOBER 5, 1984 AND STILL OPERATING.





EARTH RADIATION BUDGET EXPERIMENT (ERBE) NONSCANNING ACTIVE-CAVITY RADIOMETERS (ACR) WERE LAUNCHED ABOARD THE ERBS SPACECRAFT OCT. 1984





THE EARTH RADIATION BUDGET EXPERIMENT (ERBE) ACTIVE-CAVITY RADIOMETERS (ACR) SENSOR DESIGN

FOUR [4] ERBE NONSCANNING ACTIVE CAVITY RADIOMETERS:

(1) TOTAL WIDE FIELD-OF-VIEW [TWFOV]

FOV: 142.8°, ENTIRE EARTH; λ : 0.2 - < 50 MICROMETERS;

(2) SHORTWAVE WIDE FIELD-OF-VIEW [SWFOV]

FOV: 142.8°, ENTIRE EARTH; λ : 0.2 - 5.0 MICROMETERS;

(3) TOTAL MEDIUM FIELD-OF-VIEW [TMFOV]

**FOV: 88.4° DIAMETER LATITUDAL REGIONS ; λ : 0.2 - < 50
MICROMETERS; AND**

(4) SHORTWAVE MEDIUM FIELD-OF-VIEW [SMFOV]

**FOV: 88.4° DIAMETER LATITUDAL REGIONS ; λ : 0.2 - 5.0
MICROMETERS.**

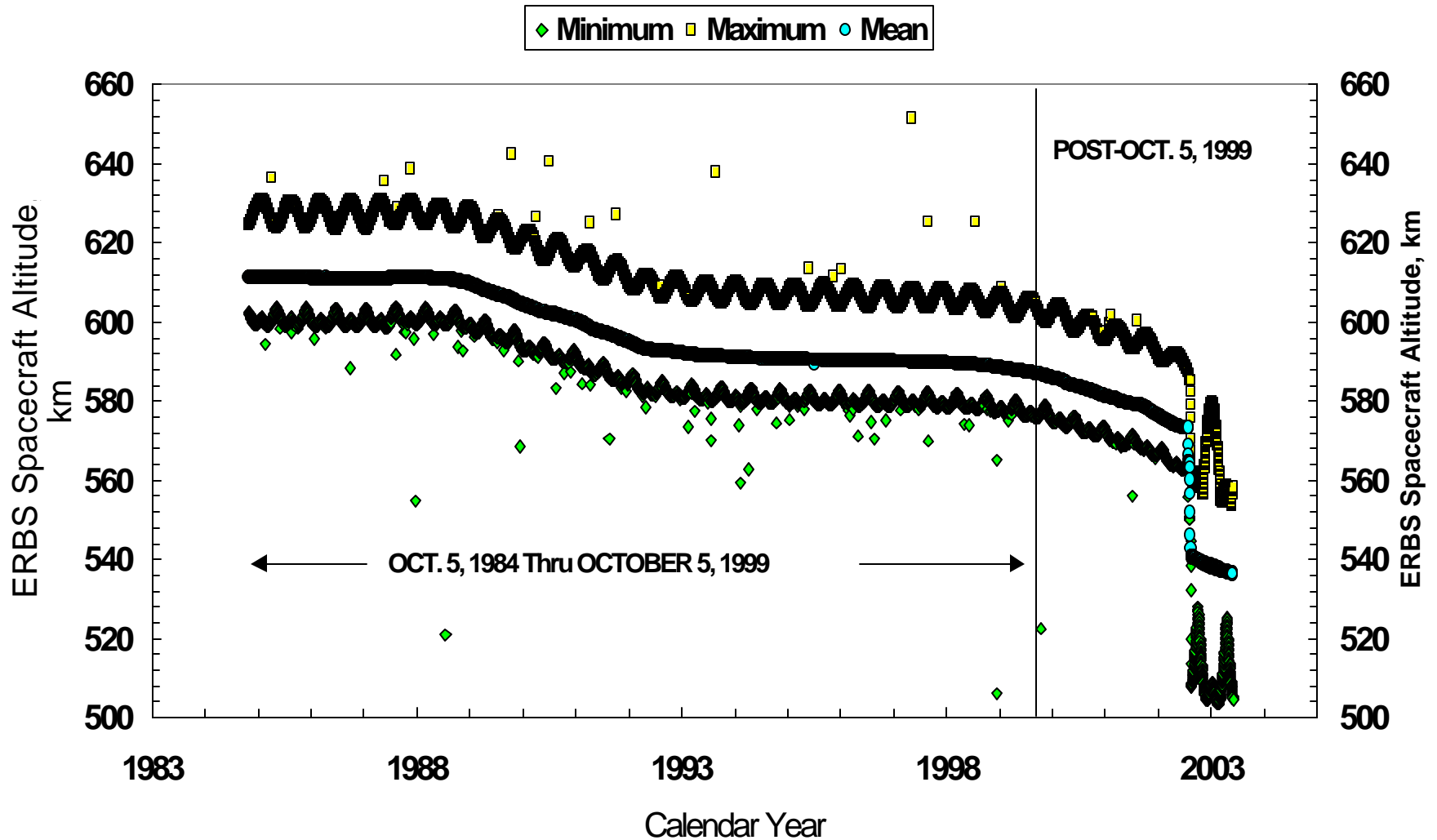


ERBE IRRADIANCE VARIABILITY CAUSED BY ERBS SPACECRAFT ALTITUDINAL VARIATIONS

ERBE IRRADIANCE VARIABILITY CAUSED BY ERBS
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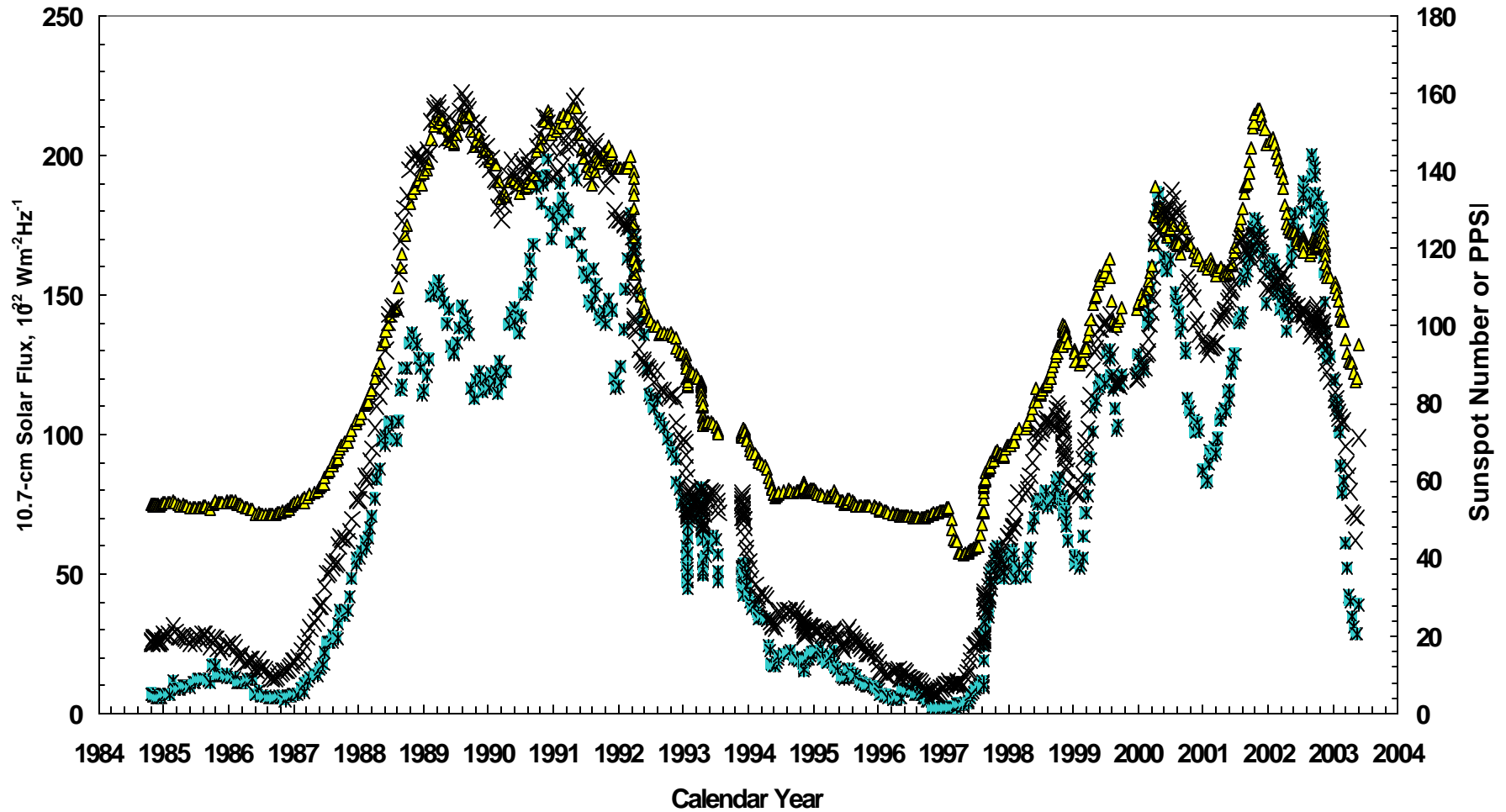
EARTH RADIATION BUDGET SATELLITE (ERBS) SPACECRAFT ALTITUDINAL VARIATIONS





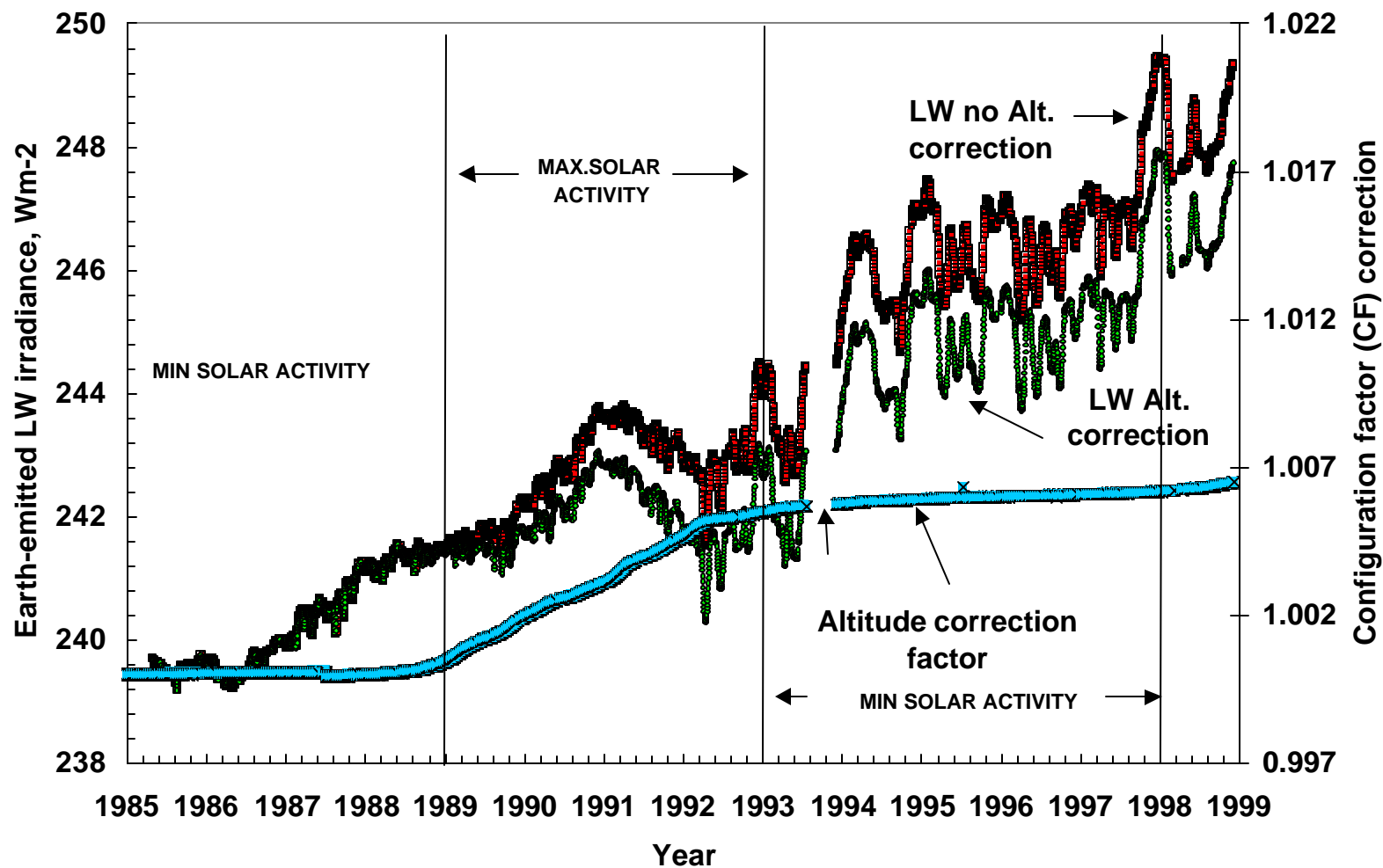
INDICES OF SOLAR MAGNETIC ACTIVITY

✱ Prompt Photometric Sunspot Index (PPSI) ▲ F10.7-cm Solar Flux × Sunspot Number



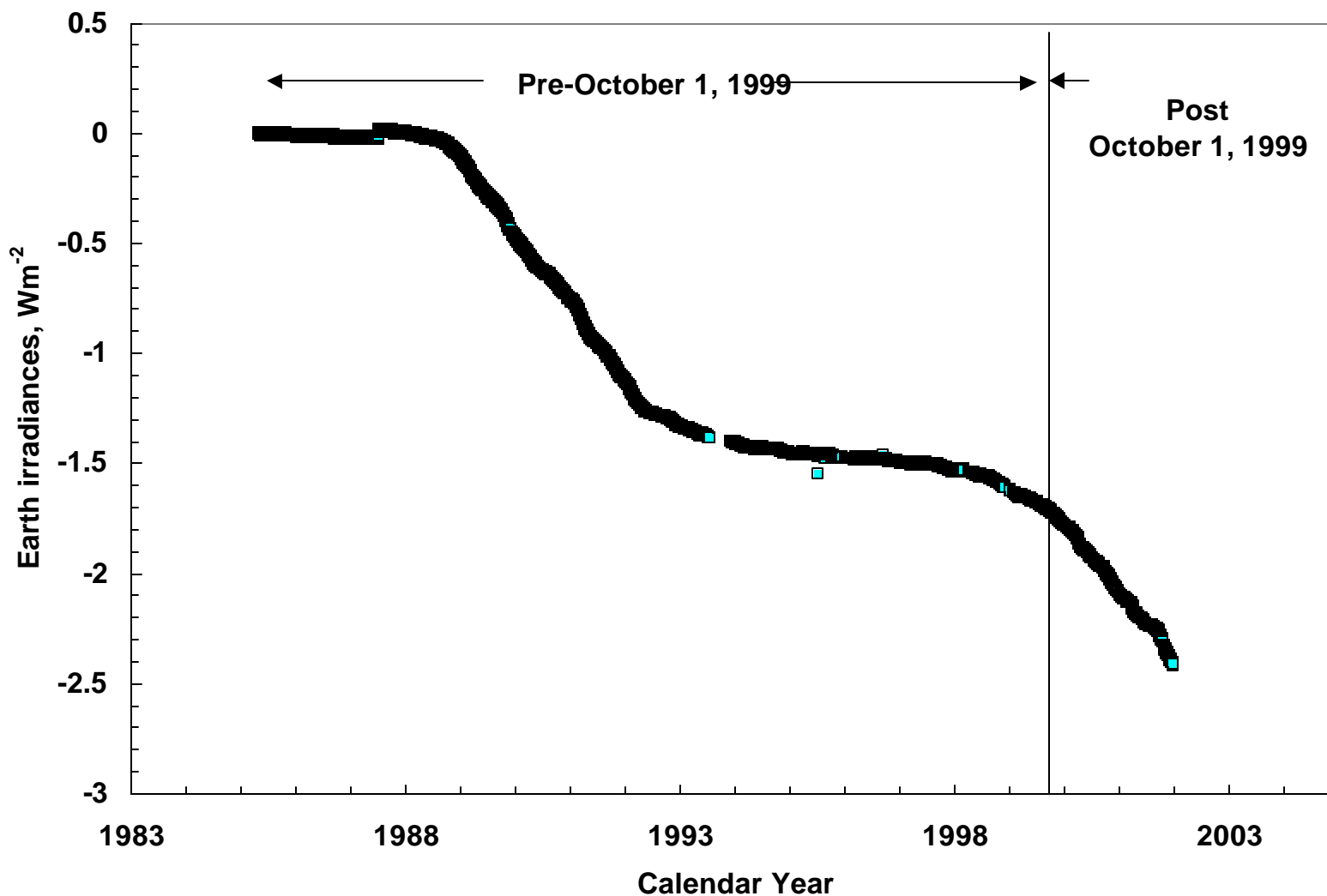


365-DAY RUNNING MEANS OF (TWFOV-SWFOV) TOA LONGWAVE EARTH IRRADIANCES FOR NO ALTITUDINAL VARIATION CORRECTIONS AND WITH ALTITUDE VARIABILITY CORRECTIONS



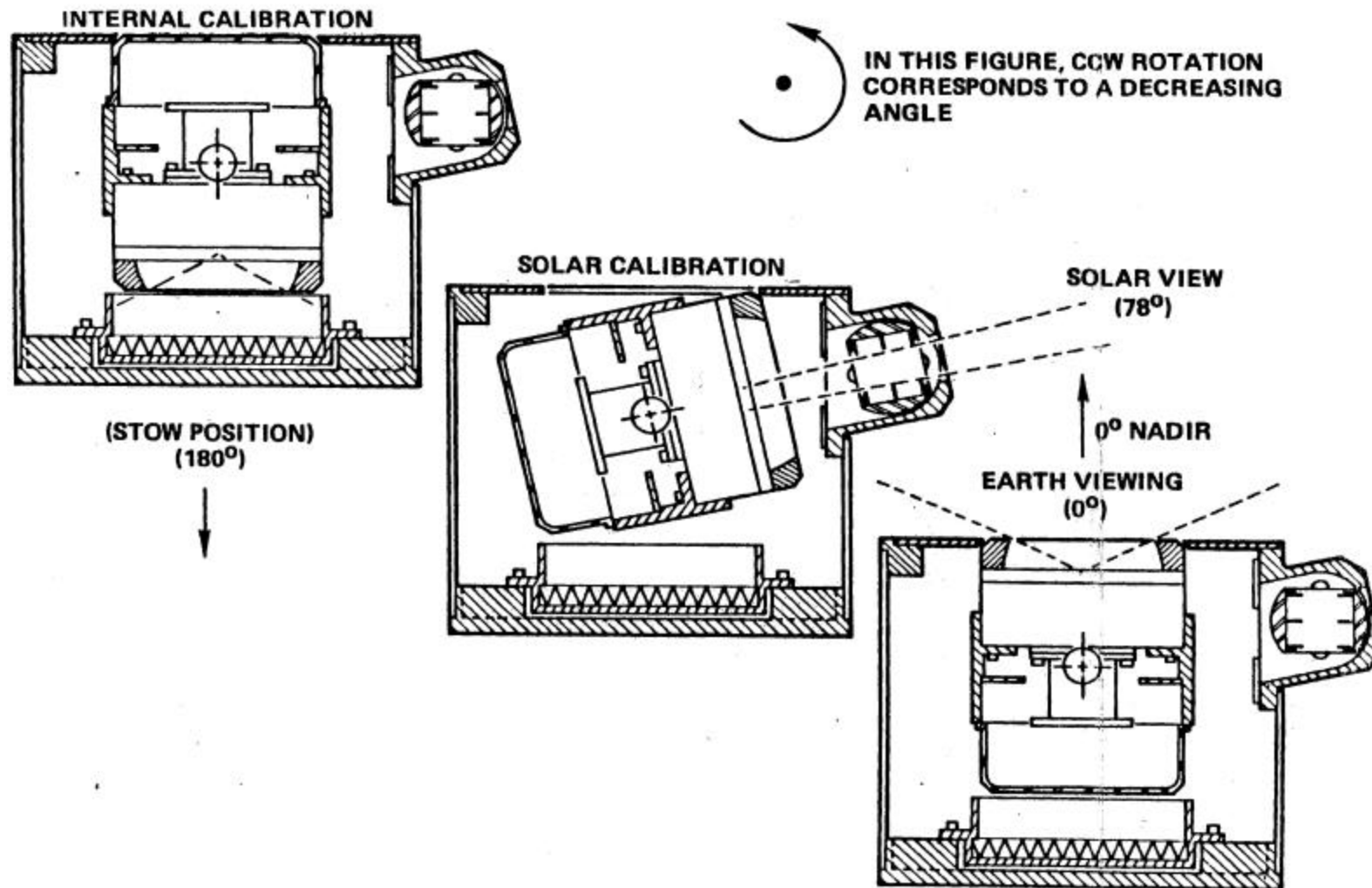


LONGWAVE IRRADIANCE CORRECTIONS FOR ERBS SPACECRAFT ALTITUDINAL VARIATIONS





ELEVATION GEOMETRY FOR **INTERNAL CALIBRATIONS** [OFFSETS], **SOLAR CALIBRATIONS** [GAINS], AND **NOMINAL EARTH-VIEWING** [OFFSETS] MEASUREMENTS

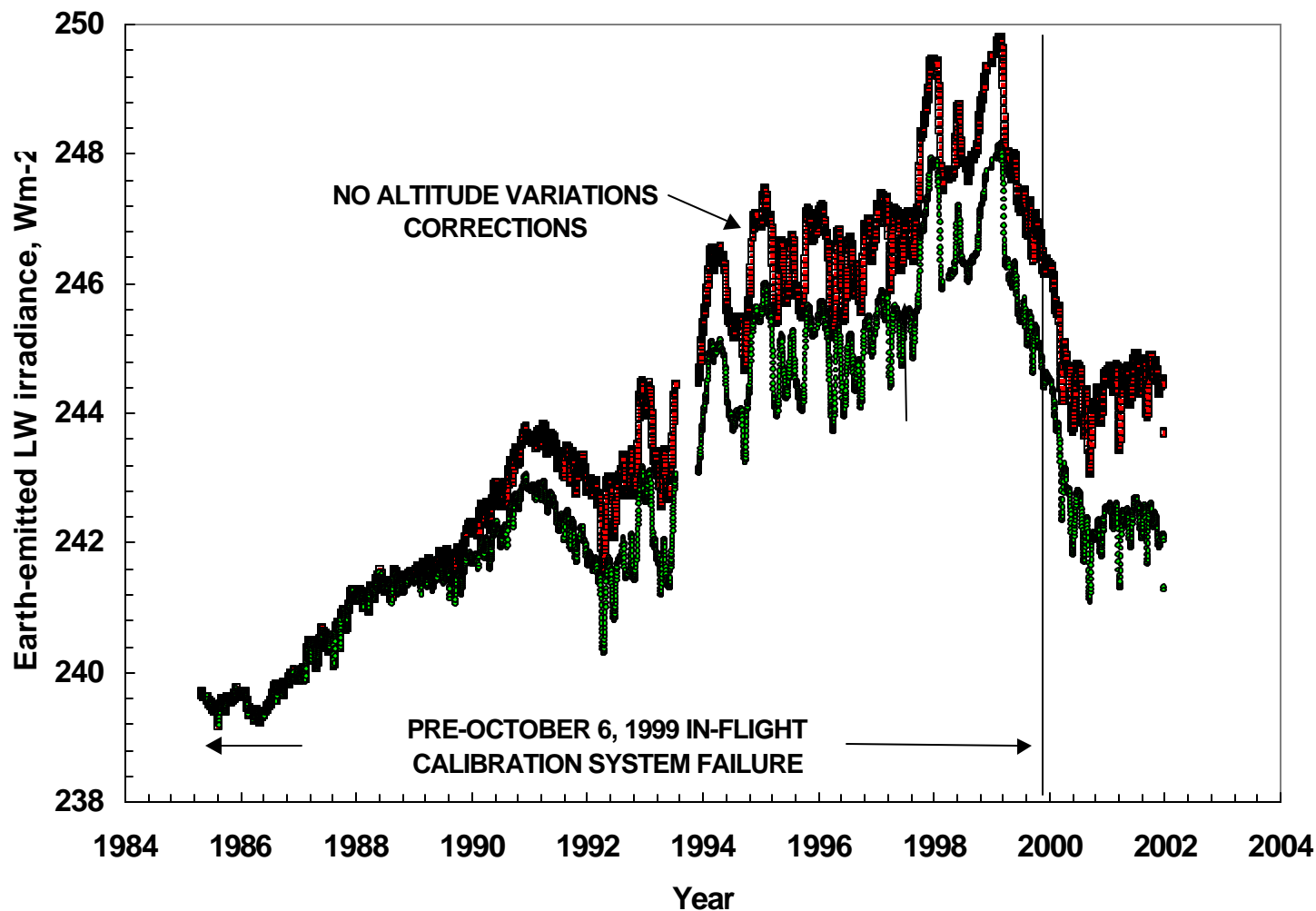




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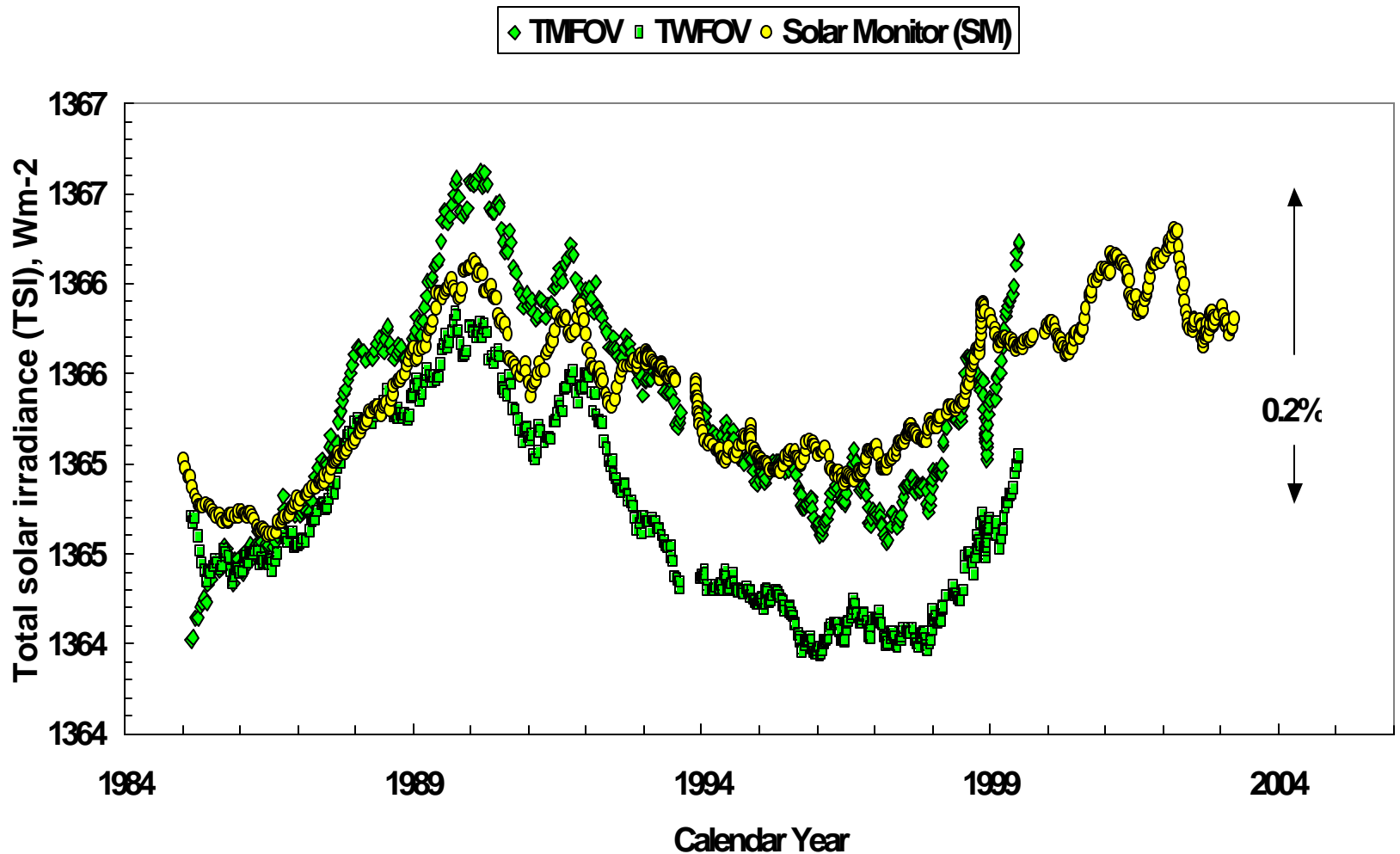


365-DAY RUNNING MEANS OF (TWFOV-SWFOV) TOA LONGWAVE EARTH IRRADIANCES FOR NO ALTITUDINAL VARIATION CORRECTIONS AND WITH ALTITUDE VARIABILITY CORRECTIONS





365-DAY RUNNING MEANS OF ERBS/ERBE TWFOV & TMFOV ACR TOTAL SOLAR IRRADIANCE (TSI) MEASUREMENTS COMPARED WITH REFERENCE SOLAR MONITOR TSI VALUES



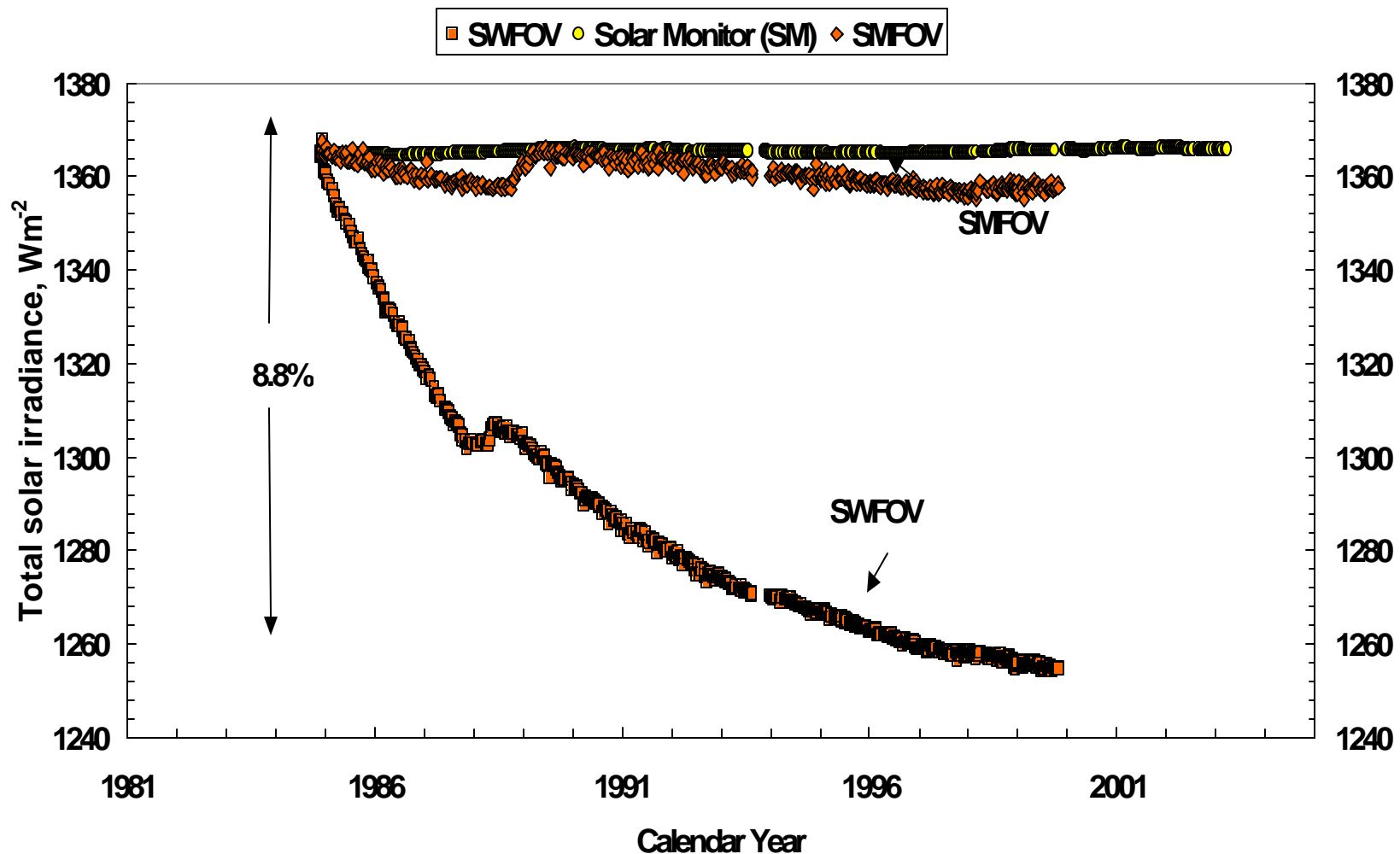


**ERBS TOTAL WIDE FIELD-OF-VIEW [TWFOV] NONSCANNER
[NS] TOTAL SOLAR IRRADIANCE [TSI] MEASUREMENTS
GAIN DRIFT OF SHIFT DETERMINATIONS**

- BETWEEN OCT. 1984 AND OCT. 1999, TWFOV TSI
VALUES SLOWLY DECREASED
APPROXIMATELY 1 Wm^{-2} OUT OF 1365 Wm^{-2} ,
0.07% TWFOV GAIN DECREASE.**
- TWFOV GAIN DECREASE WAS CAUSED BY
DEGRADATION OF ABSORTANCE OF THE
BLACK PAINT IN THE PRIMARY CAVITY.**
- TMFOV GAIN WAS STABLE AT THE 0.02% LEVEL
BETWEEN OCT. 1984 AND OCT. 1999.**



365-DAY RUNNING MEANS OF SWFOV AND SWFOV NONSCANNING ACR TOTAL SOLAR IRRADIANCE (TSI) MEASUREMENTS COMPARED WITH REFERENCE SOLAR MONITOR TSI VALUES





ERBS TOTAL WIDE FIELD-OF-VIEW [TWFOV] NONSCANNER [NS] TOTAL SOLAR IRRADIANCE [TSI] MEASUREMENTS GAIN DRIFT OF SHIFT DETERMINATIONS

- BETWEEN OCT. 1984 AND OCT. 1999, TWFOV TSI VALUES SLOWLY DECREASED APPROXIMATELY 1 Wm^{-2} OUT OF 1365 Wm^{-2} , 0.07% TWFOV GAIN DECREASE.**
- TWFOV GAIN DECREASE WAS CAUSED BY DEGRADATION OF ABSORTANCE OF THE BLACK PAINT IN THE PRIMARY CAVITY.**
- TWFOV AND SHORTWAVE WIDE FIELD-OF-VIEW [SWFOV] NONSCANNERS [NS] WERE EXPOSED TO DIRECT UV SOLAR IRRADIANCES TWICE EVERY ORBIT. THE DIRECT IRRADIANCES CAUSED THE SWFOV NS GAIN TO DECREASE APPROXIMATELY 8.8%.**



**EARTH RADIATION BUDGET EXPERIMENT (ERBE)
NONSCANNING ACR'S,
SPACECRAFT SOLAR CALIBRATION PITCH MANEUVERS**

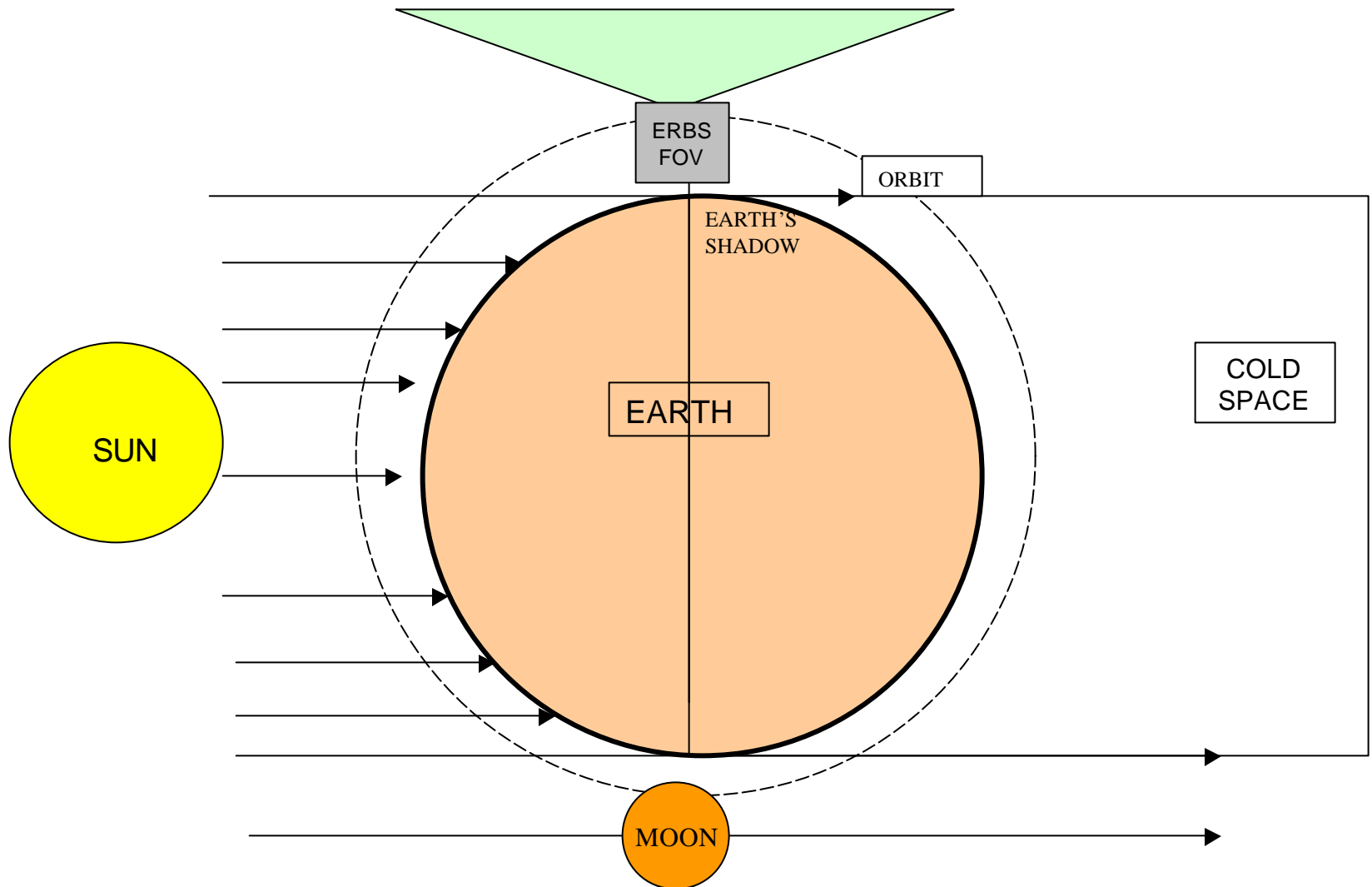
**VALIDATE ERBE ACR GAIN CALIBRATION
APPROACH**

**ERBS SPACECRAFT PITCHED 180 DEGREES FROM
EARTH'S NADIR; AND**

**NONSCANNING ACR MEASURE IRRADIANCES
FROM DEEP SPACE TO DETERMINE ACR OFFSETS.**



GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR OFFSET DETERMINATIONS





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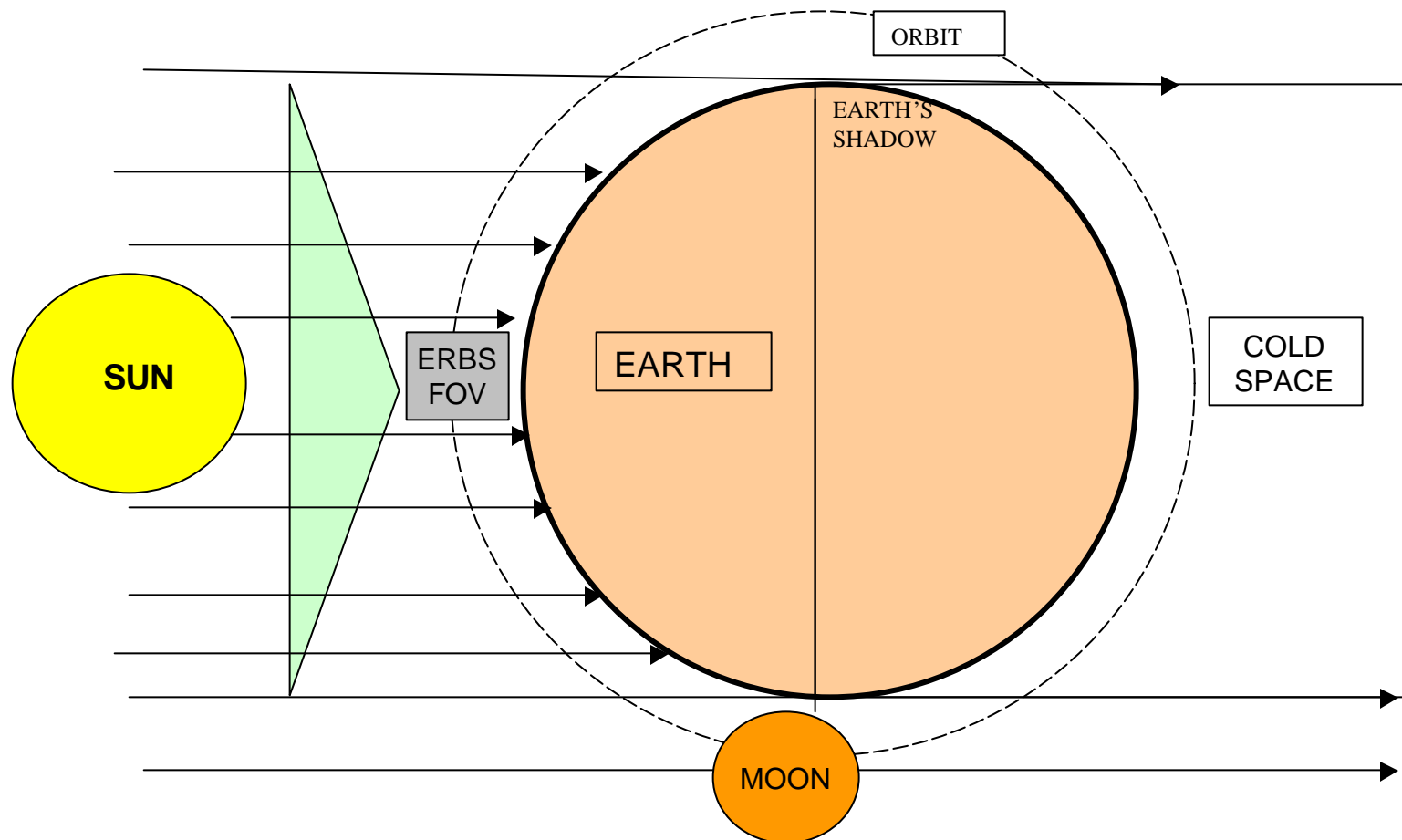
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GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR RESPONSE/GAIN DETERMINATIONS





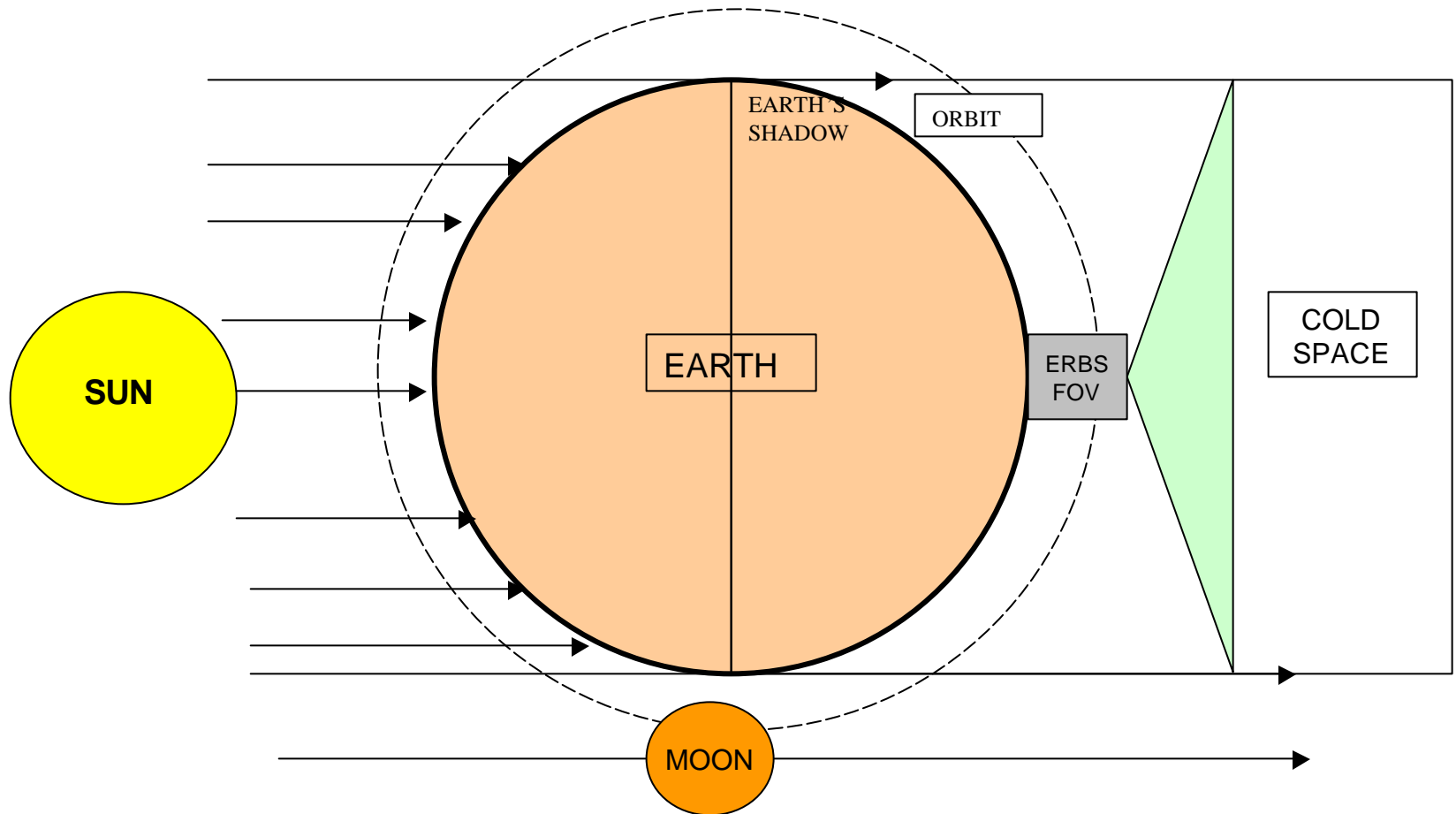
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ERBS SPACECRAFT [S/C] SCHEDULED 180-DEGREE PITCH MANEUVERS

DATE	CALIBRATION OBJECTIVE	VELOCITY VECTOR
NOVEMBER 21, 1984	SENSOR GAINS & OFFSETS	+
OCTOBER 19, 1985	SENSOR GAINS & OFFSETS	—
JULY 23, 2002	SENSOR OFFSETS	+
AUGUST 8, 2002	SENSOR OFFSETS	+
DECEMBER 4, 2002	SENSOR GAIN	-
DECEMBER 10, 2002	SENSOR OFFSETS	+
SEPTEMBER 16 & 17, 2003	SENSOR GAIN & OFFSETS	+

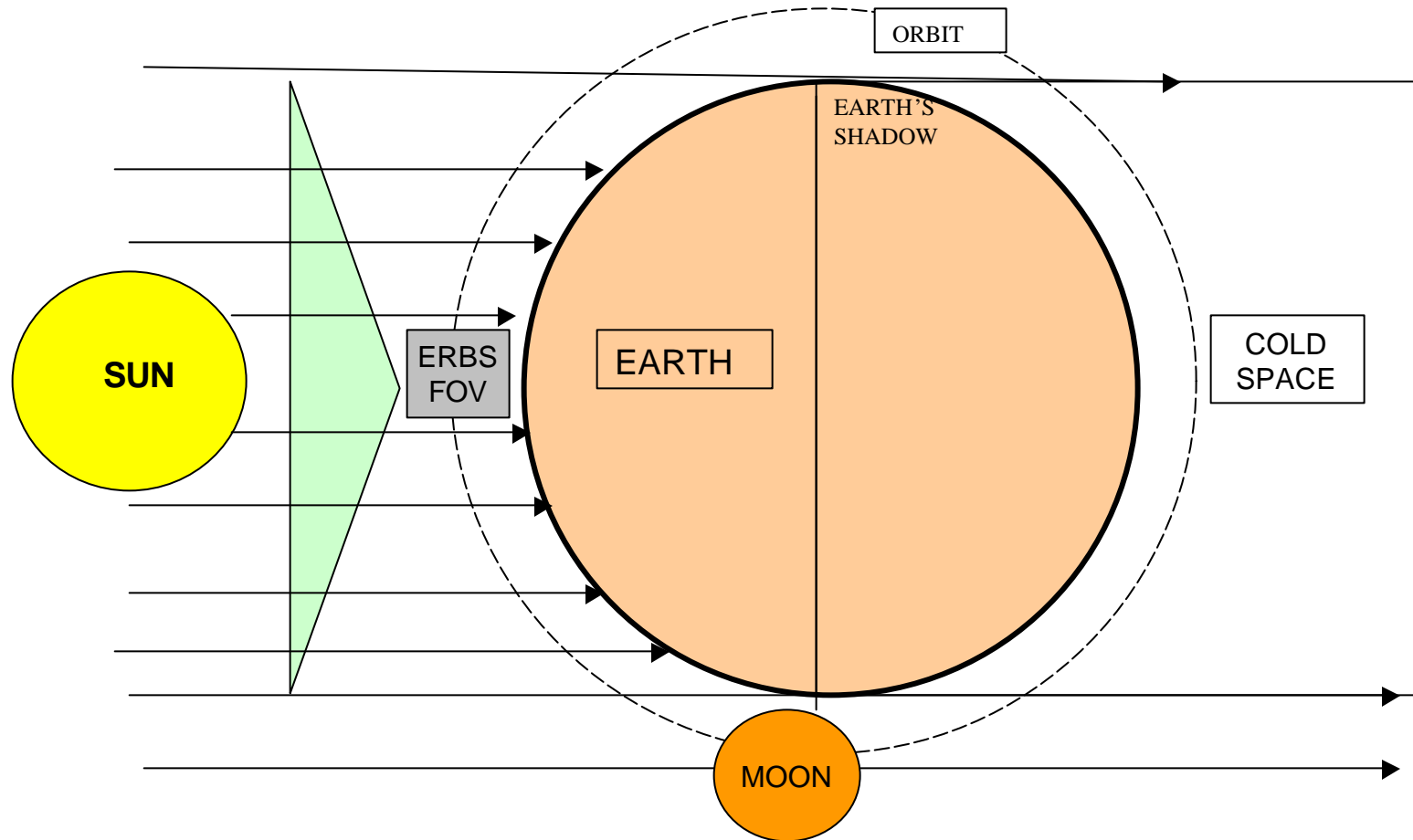


ERBS SPACECRAFT [S/C] ERBE UNSCHEDULED 180-DEGREE PITCH MANEUVERS

NONSCANNER POWER OFF ON		EVENT	VELOCITY VECTOR
JULY 2, 1987	JULY 3, 1987	LOST S/C ATTITUDE CONTROL DURING YAW MANEUVER	+
JAN. 16, 1999	FEB. 5, 1999	BATTERY CELL FAILURE	+
NOV. 16, 2000	NOV. 17, 2000	LOST S/C ATTITUDE CONTROL	+



GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR RESPONSE/GAIN DETERMINATIONS





ERBS SPACECRAFT [S/C] SCHEDULED 180-DEGREE PITCH MANEUVERS

DATE	CALIBRATION OBJECTIVE	VELOCITY VECTOR
NOVEMBER 21, 1984	GAIN & OFFSET VALIDATIONS	+
OCTOBER 19, 1985	GAIN & OFFSET VALIDATIONS	—
DECEMBER 4, 2002	GAIN DETERMINATIONS	--
SEPTEMBER 16, 2003	GAIN DETERMINATIONS	+
SEPTEMBER 17, 2003	OFFSET DETERMINATIONS	+



DETERMINATION OF POST OCT. 6, 1999 ERBS/ERBE NONSCANNER ELEVATION DRIVE ANGLE

TSI VALUES

DATE	TWFOV [Wm-2]	SWFOV [Wm-2]	TMFOV [Wm-2]	SMFOV [Wm-2]
11/21/1984	1369.4	1352.0	1372.0	1365.1
10/20/1985	1368.7	1331.0	1371.5	1364.7
12/04/2002	1317.7	1194.3	1318.2	1312.0
09/16/2003	1376.8	1243.6	1373.2	1357.8

INVERSE COSINE ((12/04/2002 TSI)*(DF))/11/21/1984) =

	ELEV. ANGLE			
	TWFOV	SWFOV	TMFOV	SMFOV
ANGLE,DEGS.	15.8	16.1	16.1	15.0
*DCF	1.0	1.0879	1.0	1.00502

*** FILTER TRANSMISSION DEGRADATION CORRECTION FACTOR**

**IMPLIES THAT ELEVATION ANGLE WAS SET BETWEEN 15 & 16.1 DEGREES
AFTER OCTOBER 4, 1999 ELEVATION AXIS FAILURE.**



SWFOV AND SMFOV NONSCANNER [NS] OFFSET DETERMINATIONS FROM OBSERVATIONS OF THE EARTH NIGHT SIDE

SHORTWAVE ACR'S WERE ROTATED TO THE 0-DEGREE
ELEVATION POSITION TO MEASURE EARTH NIGHT
SIDE IRRADIANCES IN ORDER TO DETERMINE THE
ZERO-IRRADIANCE OFFSETS.

**NOTE: IF NIGHT TIME EARTH MEASUREMENTS WERE NOT AVAILABLE,
SHORTWAVE ACR OFFSETS WERE DETERMINED FROM
MEASUREMENTS OF TUNGSTEN LAMP IRRADIANCE WHILE THE
LAMP WAS OFF.**



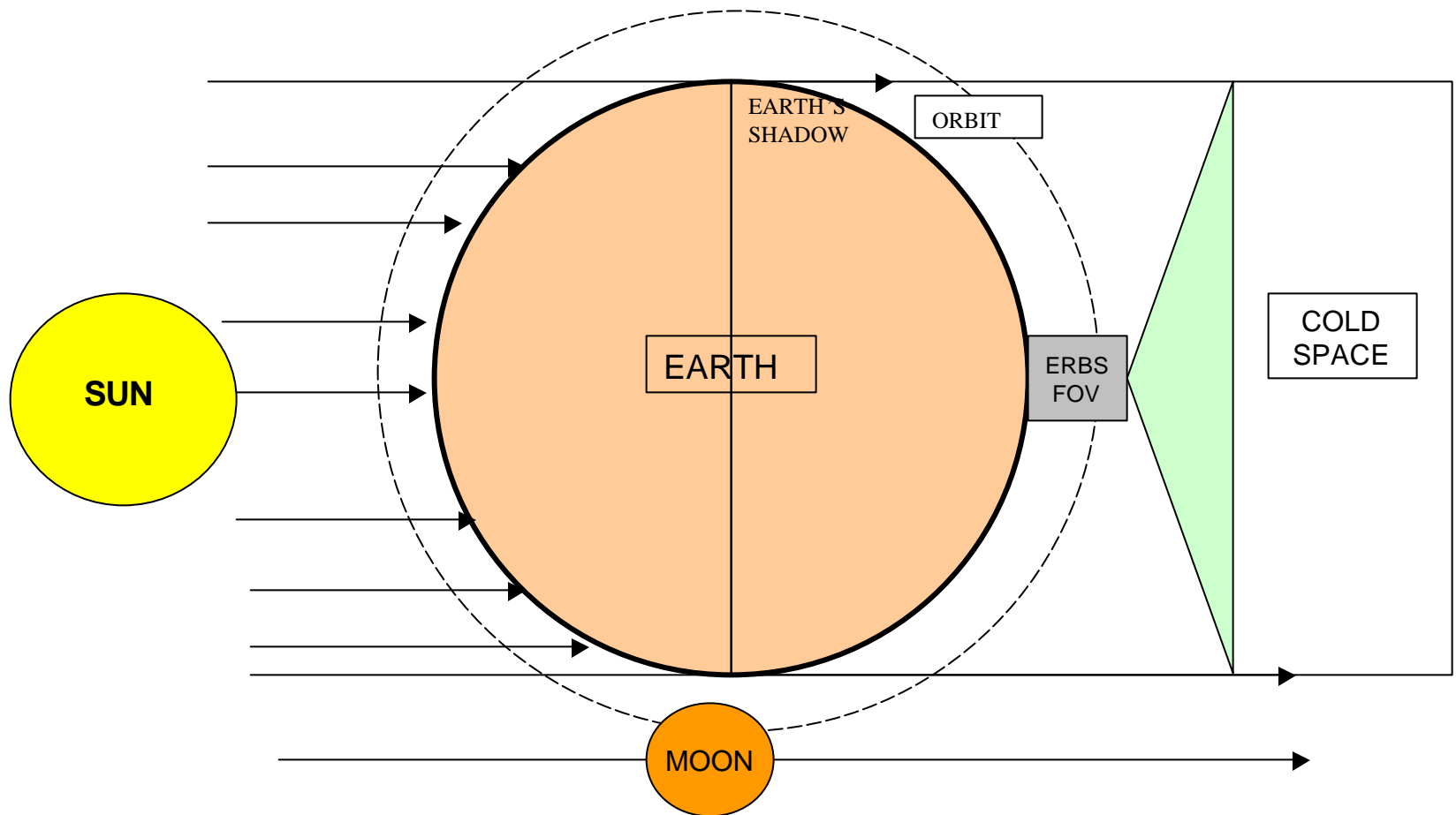
EARTH RADIATION BUDGET EXPERIMENT (ERBE) NONSCANNING ACR, DEEP SPACE CALIBRATION MANEUVERS

SENSOR OFFSETS VALIDATION/DETERMINATION FROM DEEP SPACE OBSERVATIONS

**ERBS PITCHED 180 DEGREES FROM EARTH'S
NADIR; AND**

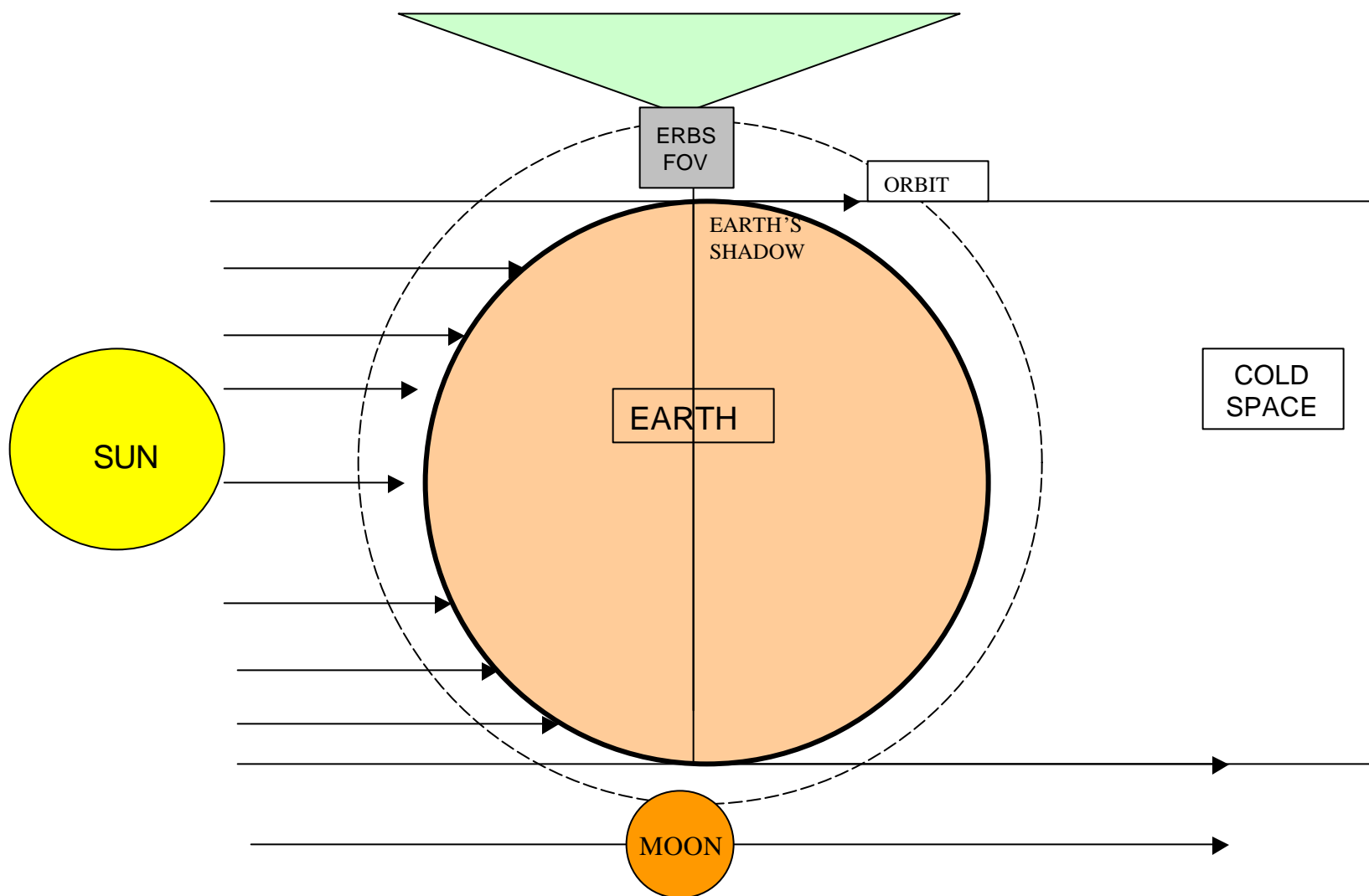
**NONSCANNING ACR MEASURE ZERO-
IRRADIANCE OF DEEP COLD SPACE, SUN
LOCATED OUTSIDE OF ACR FOV.**

GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR OFFSET DETERMINATIONS





GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR OFFSET DETERMINATIONS





TOTAL WIDE FIELD-OF-VIEW [TWFOV] NONSCANNER OFFSETS AT SATELLITE ALTITUDES DEEP SPACE PITCH MANEUVER RESULTS

DATES		CALIBRATION SOURCES	
	BLACKBODY	SPACE	DIFFERENCES
21-NOV-84	1703.3 Wm^{-2}	1703.7 Wm^{-2}	-0.4 Wm^{-2}
19-OCT-85	1704.5 Wm^{-2}	1704.2 Wm^{-2}	+0.3 Wm^{-2}
*2-JULY-87	1705.8 Wm^{-2}	1706.3 Wm^{-2}	-0.5 Wm^{-2}
*16-JAN-99	1713.5 Wm^{-2}	1714.2 Wm^{-2}	-0.7 Wm^{-2}
16-NOV-00	NO CAL.	1667.9 Wm^{-2}	N/A
23-JULY-02	NO CAL.	1669.8 Wm^{-2}	N/A
8-AUG-02	NO CAL.	1669.7 Wm^{-2}	N/A
10-DEC-02	NO CAL.	1669.6 Wm^{-2}	N/A

* DENOTES DATES WHEN ATTITUDE CONTROL OF THE ERBS WAS LOST.



TOTAL MEDIUM FIELD-OF-VIEW [TMFOV]
NONSCANNER OFFSETS AT SATELLITE ALTITUDES
DEEP SPACE PITCH MANEUVER RESULTS

DATES	CALIBRATION SOURCES		
	BLACKBODY	SPACE	DIFFERENCES
21-NOV-84	1277.3 Wm^{-2}	1276.9 Wm^{-2}	-0.4 Wm^{-2}
19-OCT-85	1279.8 Wm^{-2}	1277.5 Wm^{-2}	-2.3 Wm^{-2}
*2-JULY-87	1276.4 Wm^{-2}	1278.0 Wm^{-2}	+1.6 Wm^{-2}
*16-JAN-99	1273.8 Wm^{-2}	1273.5 Wm^{-2}	-0.3 Wm^{-2}
*16-NOV-00	NO CAL.	1254.8 Wm^{-2}	N/A
23-JULY-02	NO CAL.	1252.6 Wm^{-2}	N/A
8-AUG-02	NO CAL.	1254.5 Wm^{-2}	N/A
10-DEC-02	NO CAL.	1253.1 Wm^{-2}	N/A

* DENOTES DATES WHEN ATTITUDE CONTROL OF THE ERBS WAS LOST.



TOTAL WIDE FIELD-OF-VIEW NONSCANNER OFFSETS AT SATELLITE ALTITUDES

**COMPARISONS VALIDATE THAT THE
BLACKBODY MEASUREMENTS YIELDED
SENSOR OFFSETS WITHIN 0.5 Wm^{-2} OF THOSE
OFFSETS DERIVED FROM REFERENCE, NEAR
ZERO-IRRADIANCE SOURCE FROM 3 DEGS.
KELVINS DEEP SPACE.**



SHORTWAVE WIDE FIELD-OF-VIEW [SWFOV] OFFSETS AT SATELLITE ALTITUDES ERBS PITCH MANEUVERS

DATE	NIGHT SPACE GAIN COR. SPACE- NIGHT FACTOR	FOVL TEMP @NIGHT
	WATTS PER SQUARE METER	DEG. K
21-Nov-84	1299.9 1304.8 0.9981 4.9	21.9
19-Oct-85	1324.4 1329.8 1.0193 5.4	22.1
*2-Jul-87	1361.4 1367.1 1.0445 5.7	22.3
*16-Jan-99	1401.6 1412.3 1.0874 10.7	28.4
*16-Nov-00	1405.9 1411.9 1.0880 6.0	22.5
23-July-02	1406.1 1411.6 1.0880 5.4	22.5
8-AUG-02	1406.8 1411.9 1.0879 5.1	23.0
10-DEC-02	1406.1 1411.7 1.0879 5.6	22.6

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SHORTWAVE WIDE FIELD-OF-VIEW [SWFOV] OFFSETS AT SATELLITE ALTITUDES

- DIFFERENCES BETWEEN SPACE AND NIGHT
SENSOR OFFSETS SHOULD BE APPROXIMATELY
 6 Wm^{-2} [A_E TERM TIMES AVERAGED NIGHT OLR].**
- NEAR CONSTANT DIFFERENCES BETWEEN THE
SPACE & NIGHT SENSOR OFFSETS INDICATE
MEASUREMENT PRECISIONS APPROACHING
 1 Wm^{-2} .**
- JAN 16, 1999, NIGHT OFFSET WAS APPROXIMATELY
 4 Wm^{-2} TOO LOW BECAUSE OF DAYSIDE
CONTAMINATION DURING A TERMINATION ORBIT.**



Comparisons of SMFOV offsets derived from measurements of the earth night side and of cold space at satellite altitudes.

Date	Offset (B_{sw})		Offset (B_{sw}) Differences (Wm^{-2})	FOVL Temperature @Night	Gain Correction Factor
	Night (Wm^{-2})	Space (Wm^{-2})			
21 November 1984	1011.1	1013.1	2.0	21.9	0.9997
19 October 1985	1019.3	1025.5	6.3	22.1	1.00154
02 July 1987	1036.5	1043.5	7.0	22.3	1.0040
16 January 1999	1019.8	1025.0	5.2	28.4	1.00578
16 November-2000	1019.9	1023.9	4.0	22.5	1.00502
23 July 2002	1007.1	1009.5	2.4	22.8	1.00502
08 August 2002	1017.8	1019.9	2.3	22.7	1.00502
10 December 2002	1014.6	1016.5	1.9	23.2	1.00502



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ERBS FIELD-OF-VIEW (FOV) AND SPATIAL CHARACTERISTICS

RADIOMETER	EARTH		SOLAR		PRIMARY	APERT.	SECOND.	SPECTRAL
	FOV		FOV		APERT.	DISTANT	APERT.	RANGE
	q_1 Deg.	q_2 Deg.	q_1 Deg.	q_2 Deg.	r_1 cm	h cm	r_2 cm	λ μm
TOTAL WFOV	68	71.4	4.10	8.80	0.318	1.270	3.460	0.2-100
SHORTWAVE WFOV	68	71.4	4.10	8.80	0.318	1.270	3.460	0.2-5
TOTAL MFOV	37	44.2	3.30	6.97	0.318	2.883	2.489	0.2-100
SHORTWAVE MFOV	37	44.2	3.30	6.97	0.318	2.883	2.489	0.2-5

q_1 - unencumbered FOV half angle

q_2 - zero response half angle beyond which the detector response to the target scene is zero.

h - height/distance between the primary and secondary apertures

r_1 - radius of primary aperture

r_2 - radius of secondary aperture



ANALYSES OF ERBS WIDE FIELD-OF-VIEW (WFOV) NONSCANNER GAINS USING 1984 AND 1985 SOLAR CALIBRATIONS TOTAL WFOV GAINS

SOLAR PORTS

NOVEMBER 20, 1984

TSI = 1376.5 Wm^{-2}

DEEP SPACE MANEUVERS

NOVEMBER 21, 1984

TSI = 1369.4 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1371.0 Wm^{-2} : AZ AXIS = 90 DEGS.

SOLAR PORTS

OCTOBER 20, 1985

TSI = 1376.7 Wm^{-2}

DEEP SPACE MANEUVERS

OCTOBER 19, 1985

TSI = 1368.7 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1368.9 Wm^{-2} : AZ AXIS = 90 DEGS.

OCTOBER 16, 1985

TSI = 1375.5 Wm^{-2}

TWFOV GAIN CORRECTION FACTOR

RATIO $1376.7/1376.5 = 1.0002$

RATIO $1368.8/1370.2 = 0.9990$



ANALYSES OF ERBS MEDIUM FIELD-OF-VIEW (MFOV) NONSCANNER GAINS USING 1984 AND 1985 SOLAR CALIBRATIONS TOTAL MFOV GAINS

SOLAR PORTS

DEEP SPACE MANEUVERS

DECEMBER 3, 1984

TSI = 1361.4 Wm⁻²

NOVEMBER 21, 1984

TSI = 1372.0 Wm⁻²: AZ AXIS = 0 DEG.

TSI = 1374.3 Wm⁻²: AZ AXIS = 90 DEGS.

SOLAR PORTS

DEEP SPACE MANEUVERS

OCTOBER 20, 1985

TSI = 1363.6 Wm⁻²

OCTOBER 19, 1985

TSI = 1371.5 Wm⁻²: AZ AXIS = 0 DEG.

TSI = 1372.5 Wm⁻²: AZ AXIS = 90 DEGS.

OCTOBER 16, 1985

TSI = 1360.3 Wm⁻²

TMFOV GAIN CORRECTION FACTOR

RATIO 1363.6/1361.4 = 1.0016

RATIO 1372.0/1373.2 = 0.9991



ANALYSES OF ERBS WIDE FIELD-OF-VIEW (WFOV) NONSCANNER GAINS USING 1984 AND 1985 SOLAR CALIBRATIONS SHORTWAVE WFOV GAINS

SOLAR PORTS

NOVEMBER 20, 1984

TSI = 1357.2 Wm^{-2}

DEEP SPACE MANEUVERS

NOVEMBER 21, 1984

TSI = 1352.0 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1352.8 Wm^{-2} : AZ AXIS = 90 DEGS.

SOLAR PORTS

OCTOBER 20, 1985

TSI = 1335.4 Wm^{-2}

DEEP SPACE MANEUVERS

OCTOBER 19, 1985

TSI = 1331.0 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1331.6 Wm^{-2} : AZ AXIS = 90 DEGS.

OCTOBER 16, 1985

TSI = 1334.4 Wm^{-2} .

SWFOV GAIN CORRECTION FACTOR

RATIO $1335.4/1357.2 = 0.9839$

RATIO $1331.3/1352.4 = 0.9844$



ANALYSES OF ERBS MEDIUM FIELD-OF-VIEW (WFOV) NONSCANNER GAINS USING 1984 AND 1985 SOLAR CALIBRATIONS SHORTWAVE MFOV GAINS

SOLAR PORTS

DEEP SPACE MANEUVERS

NOVEMBER 20, 1984

TSI = 1362.2 Wm^{-2}

NOVEMBER 21, 1984

TSI = 1365.1 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1372.2 Wm^{-2} : AZ AXIS = 90 DEGS.

SOLAR PORTS

DEEP SPACE MANEUVERS

OCTOBER 20, 1985

TSI = 1357.2 Wm^{-2}

OCTOBER 19, 1985

TSI = 1364.7 Wm^{-2} : AZ AXIS = 0 DEG.

TSI = 1365.6 Wm^{-2} : AZ AXIS = 90 DEGS.

OCTOBER 16, 1985

TSI = 1355.0 Wm^{-2}

SMFOV GAIN CORRECTION FACTOR

RATIO $1357.2/1362.2 = 0.9963$

RATIO $1365.2/1368.7 = 0.9975$



DATA REDUCTION EQUATIONS FOR SHORTWAVE AND TOTAL NONSCANNING ACR'S **GAINS AND OFFSETS**

TOTAL ACR IRRADIANCES

$$E_{\text{TOTAL}} = A_v V_A^2 + A_F T_F + A_r V_r^2 + B_{\text{TOTAL}}$$

SHORTWAVE ACR IRRADIANCES

$$E_{\text{SW}} = A_v V_A^2 + A_F T_F + A_E E_{\text{TOTAL}} + A_r V_r^2 + B_{\text{SW}}$$

A_v **ACTIVE CAVITY GAIN**

V_A **ACTIVE CAVITY HEATER VOLTAGE**

A_F **BAFFLE/FOVL-CAVITY EXCHANGE FACTOR**

T_F **BAFFLE/FOVL TEMPERATURE**

A_r **REFERENCE CAVITY GAIN**

V_r **REFERENCE CAVITY HEATER VOLTAGE**

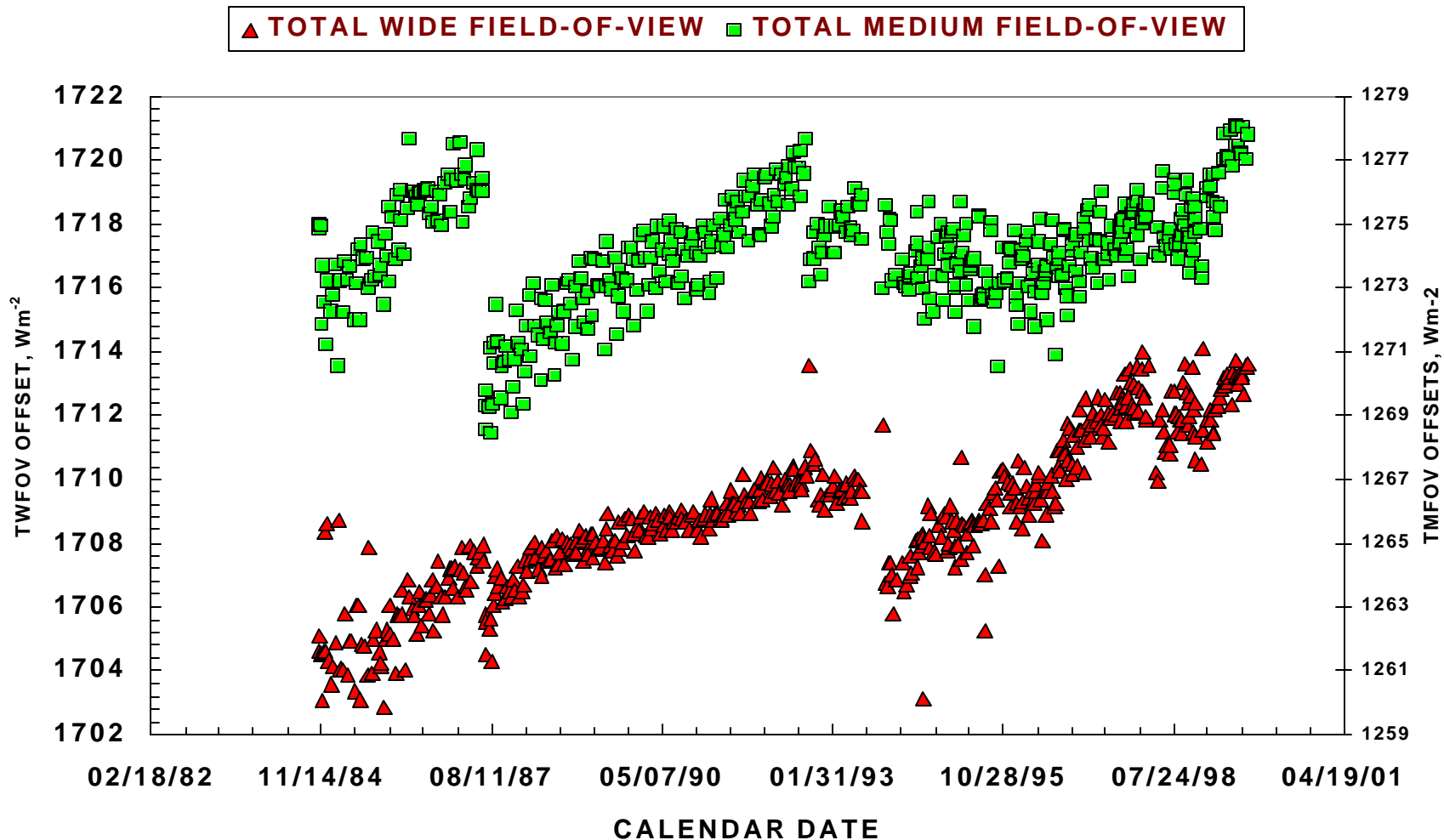
B_{TOTAL} **TOTAL ACR SENSOR, ZERO-IRRADIANCE OFFSET**

A_E **FILTER DOME LW HEATING FACTOR**

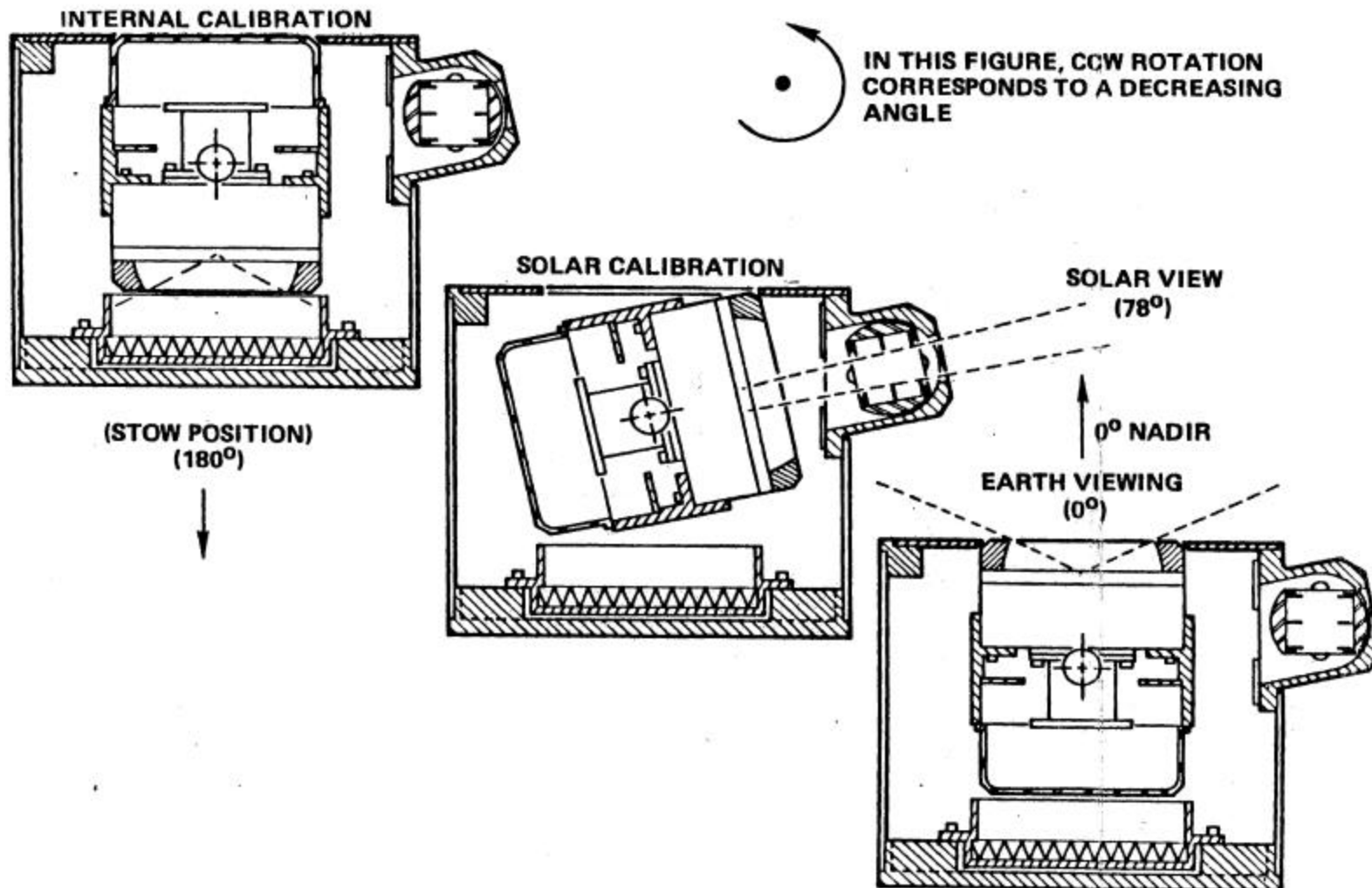
B_{SW} **SHORTWAVE ACR SENSOR, ZERO-IRRADIANCE OFFSET**



ACR SENSOR OFFSETS DETERMINED FROM OBSERVATIONS OF ON-ORBIT BLACKBODIES

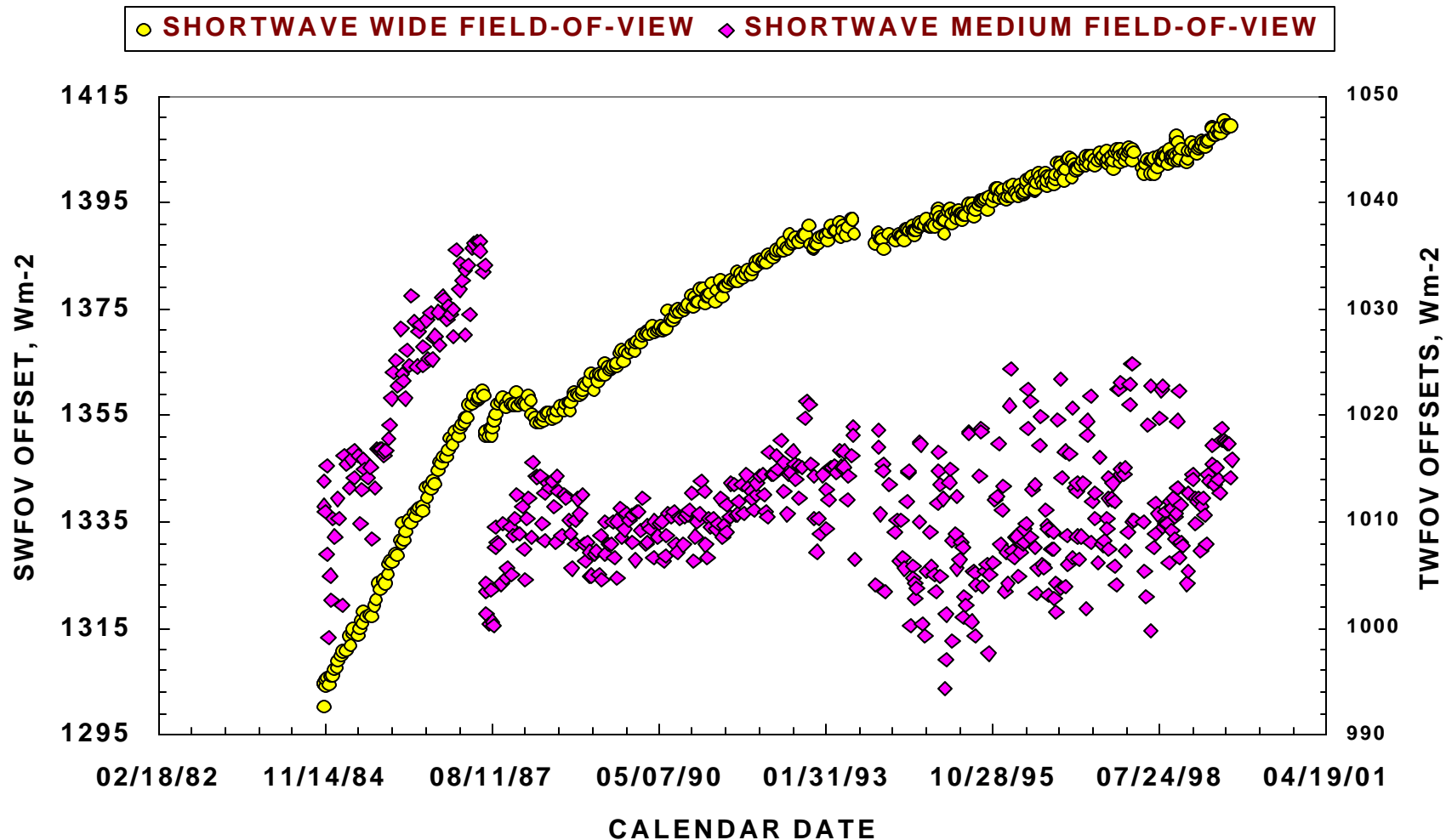


ELEVATION GEOMETRY FOR INTERNAL CALIBRATIONS [TOTAL OFFSETS], AND NOMINAL EARTH-VIEWING [SHORTWAVE OFFSETS] MEASUREMENTS





ACR SENSOR OFFSETS DETERMINED FROM OBSERVATIONS OF THE EARTH NIGHT SIDE





GAIN DETERMINATIONS AT *SOLAR CALIBRATIONS POSITION*

- 1. ACR'S WERE ROTATED TO THE 78 DEGREES IN ELEVATION POSITION AT THE SOLAR PORTS TO MEASURE TOTAL SOLAR IRRADIANCES.**
- 2. INITIAL MEASUREMENTS WERE USED AS REFERENCES TO EVALUATE GAIN CHANGES.**
- 3. EACH DAY, THE FLIGHT GAINS WERE EQUATED TO INITIAL FLIGHT GAINS DIVIDED BY GAIN CHANGES.**

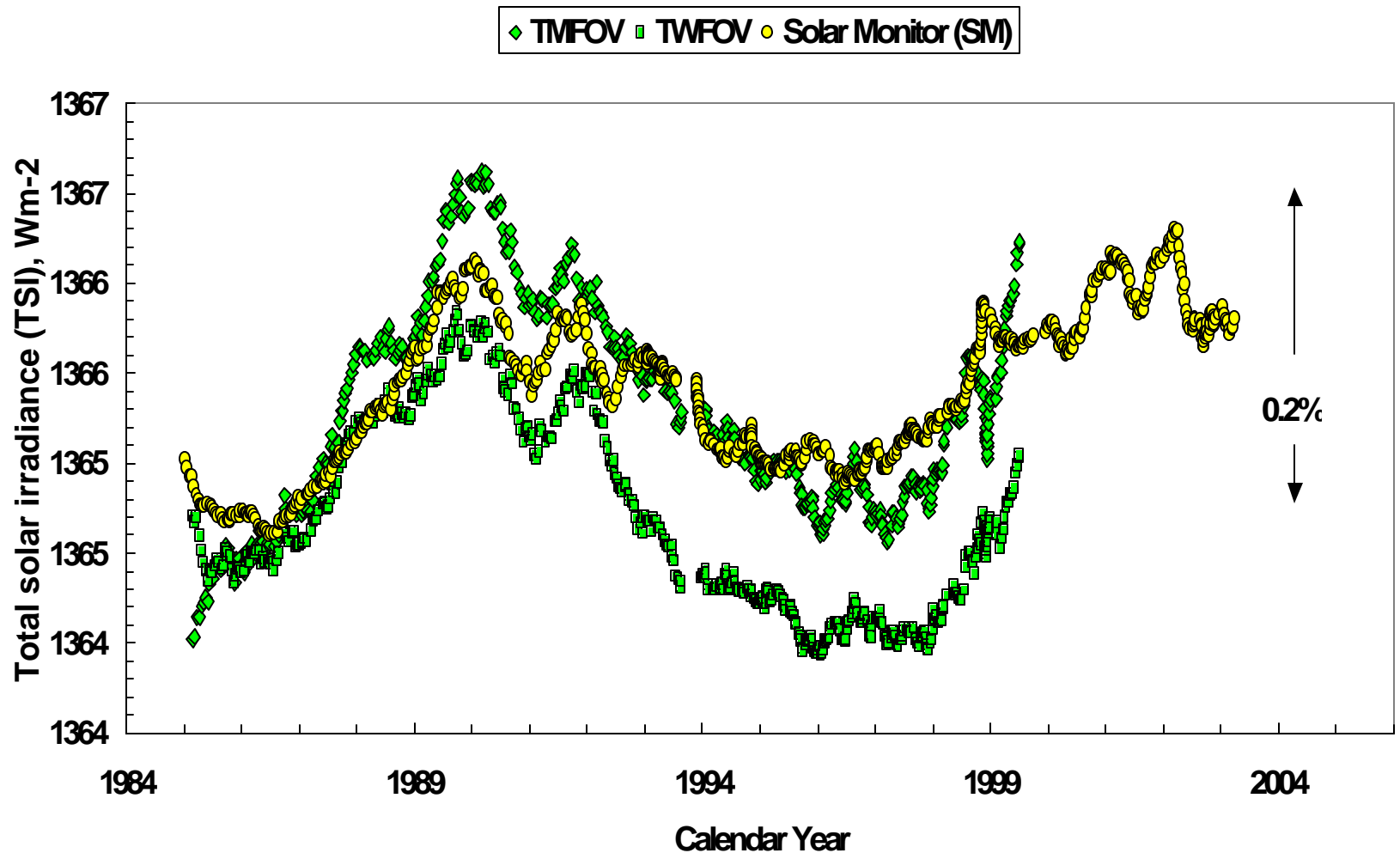


**ERBS TOTAL WIDE FIELD-OF-VIEW [TWFOV] NONSCANNER
[NS] TOTAL SOLAR IRRADIANCE [TSI] MEASUREMENTS
GAIN DRIFT OF SHIFT DETERMINATIONS**

- BETWEEN OCT. 1984 AND OCT. 1999, TWFOV TSI
VALUES SLOWLY DECREASED
APPROXIMATELY 1 Wm^{-2} OUT OF 1365 Wm^{-2} ,
0.07% TWFOV GAIN DECREASE.**
- TWFOV GAIN DECREASE WAS CAUSED BY
DEGRADATION OF ABSORTANCE OF THE
BLACK PAINT IN THE PRIMARY CAVITY.**
- TMFOV GAIN WAS STABLE AT THE 0.02% LEVEL
BETWEEN OCT. 1984 AND OCT. 1999.**



365-DAY RUNNING MEANS OF ERBS/ERBE TWFOV & TMFOV ACR TOTAL SOLAR IRRADIANCE (TSI) MEASUREMENTS COMPARED WITH REFERENCE SOLAR MONITOR TSI VALUES





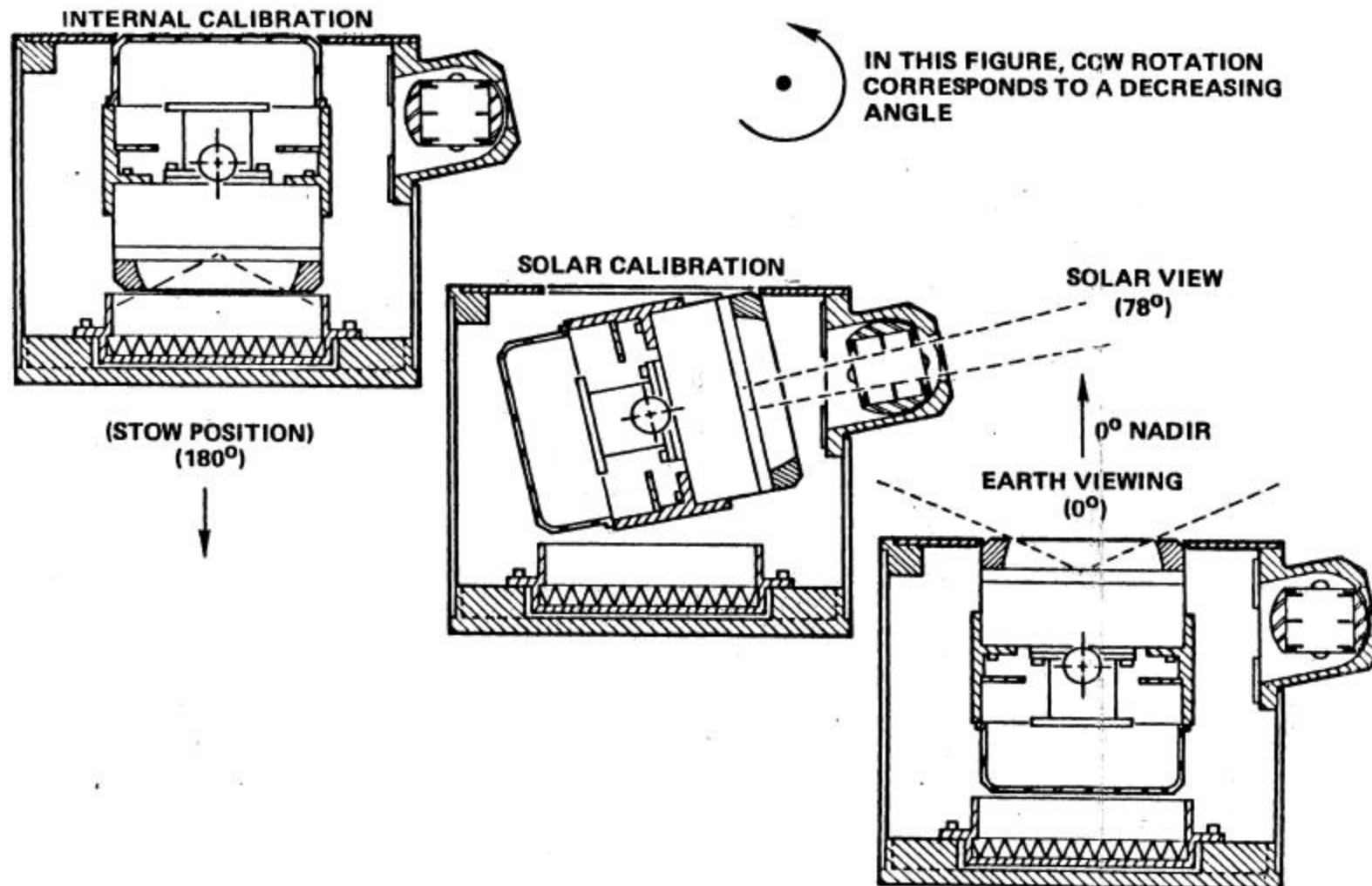
THE TOTAL NONSCANNING ACR'S PRODUCED IRRADIANCES WITH MEASUREMENT PRECISION LEVELS APPROACHING 0.5 Wm^{-2} .

THE TOTAL ACR GAINS WERE FOUND TO BE STABLE SYSTEMATICALLY AT LEVELS BETTER THAN 0.05 ± 0.02 % AND THE OFFSETS AT THE .5 Wm^{-2} LEVEL.



**SHORTWAVE ACR'S GAINS WERE FOUND
TO BE CORRECTED AT THE 0.03%
PRECISION LEVEL USING
MEASUREMENTS OF THE TOTAL SOLAR
IRRADIANCE [TSI] NORMALIZED TO THE
MEAN SUN-EARTH DISTANCE (1 AU).**

ELEVATION GEOMETRY FOR INTERNAL CALIBRATIONS [OFFSETS], **SOLAR CALIBRATIONS [GAINS]**, AND NOMINAL EARTH-VIEWING [OFFSETS] MEASUREMENTS





**ON-ORBIT CALIBRATIONS OF THE EARTH RADIATION
BUDGET EXPERIMENT (ERBE) ACTIVE-CAVITY
RADIOMETERS (ACR) ON THE EARTH RADIATION BUDGET
SATELLITE (ERBS): 1984-2002**

**OCTOBER 5, 1999, THE ERBE
ELEVATION DRIVE FAILED
PREVENTING ON-ORBIT
CALIBRATIONS OF THE ERBE ACR'S
USING THE BUILT-IN BLACKBODIES,
TUNGSTEN LAMP, AND SUN [THRU
SPECIAL SOLAR VIEWING PORTS].**



GEOMETRY FOR 180-DEGREE ERBS PITCH MANEUVER: ERBE SENSOR RESPONSE/GAIN DETERMINATIONS

